A METHOD AND A DEVICE FOR SEALING A VOID INCOMPLETELY FILLED WITH A CAST MATERIAL

This invention relates to a method for sealing a void incompletely filled with a cast material. More particularly, the method comprises the placing of an expandable material in the void which is to be filled with cast material, the expandable material expanding, when expanding, after the cast material has cured, into spaces which are not filled with cast material. The method is particularly suitable for sealing openings in an annulus round a cast-in casing as it is known from the recovery of petroleum. The invention also comprises a device for practicing the invention.

When cementing the annulus between a casing and the formation wall in a borehole, especially when approximately horizontal wells are involved, it can be very difficult or impossible to achieve complete filling of the annulus with a cast material.

The reason for this condition is essentially that a fluid present on the underside of the casing is difficult to drain completely. This fluid may include drilling fluid.

Fluid present in said annulus during the curing of the cast material, and in particular fluid present in the lower portion of the annulus, could form a channel along the borehole, which may extend so far that it connects different zones of the borehole.

It is obvious that channels of this kind are undesirable as an uncontrollable fluid transport may occur in the channel. For example, formation water from a zone may flow into a nearby petroleum-producing zone.

It is known to use an expandable material to shut off an annulus. Thus, Norwegian patent 312478 discloses a packer which is made of a swellable material. After the packer has been placed at a desired location, the material of the packer absorbs a fluid and thereby swells until it seals the annulus.

The invention has as its object to remedy or reduce at least one of the drawbacks of the prior art.

The object is realized in accordance with the invention through the features specified in the description below and in the following Claims.

Sealing of a void which is incompletely filled with a cast material, is realized according to the invention by placing

an expandable material in the void which is to be filled with cast material. The expandable material then expands into spaces which are not filled with cast material after the cast material has cured, typically by displacing a fluid.

When, for example, a casing is to be cemented in a borehole, at least one sleeve-shaped plug is placed so that it encircles the casing, before the casing is run into the borehole.

When the casing has been run to its predetermined position in the borehole, the annulus encircling the casing is filled with drilling fluid, the expandable material attempting, to a certain degree, to centralize the casing in the borehole.

When a cast material, normally in the form of concrete, then flows into the annulus, the fluid present in the annulus is essentially displaced as the volume fills with concrete.

It has turned out to be difficult, however, to drain all the fluid away from the annulus, and some fluid accumulates at the bottom of the annulus. After casting, the sleeve-shaped plug of expandable material is partly in this fluid and partly embedded in the cast material.

The expandable material will expand, for example due to swelling on contact with the fluid or by diffusion of the fluid into openings in the expandable material. Adjacent fluid is displaced by the expandable material, which thereby has the effect that, for example, a fluid channel in the lower portion of an annulus is shut off.

The expandable material may be formed, for example, by a swellable material or by a foam-like diffusible material which is compressed before being placed in the borehole, cavities in the material filling up with fluid with time, whereby the material expands. The expandable material may be designed to expand on contact with, for example, water, oil, gas or other suitable materials.

A swellable material may be selected, for example, from the group including an elastic polymer such ad EPDM rubber, styrene/butadiene, natural rubber, ethylene/propylene monomer rubber, styrene/propylene/diene monomer rubber, ethylene/vinyl acetate rubber, hydrogenated acrylonitrile/butadiene rubber, acrylonitrile/butadiene rubber, isoprene rubber, chloroprene rubber or polynorbornene. The swellable material may further include mixtures of the mentioned materials, possibly with the addition of other dissolved or mixed-in materials, such as cellulose fibre, as it is described in US patent 4,240,800. Further alternatives may be a rubber in a mechanical mixture with polyvinyl chloride, methyl methacrylate, acrylonitrile, ethyl acetate or other polymers which will expand on contact with oil.

A diffusible material can be selected from the group including nitrile rubber. As mentioned above, the diffusible material is made of an elastic material with a considerable portion of closed cavities, the material allowing the diffusion of a fluid through the material into the cavities.

The expandable materials may be provided with one or more reinforcements, for example in the form of a fibre cloth.

In what follows is described a non-limiting example of a preferred method and embodiment which are visualized in the accompanying schematic drawings, in which:

Figure 1 shows a casing which is provided with sleeves of an expandable material, and which is placed in an approximately horizontal borehole in the ground, cast material having been filled into the annulus between the casing and the borehole wall;

Figure 2 shows the same as Figure 1 after some time has passed, the expandable material having sealed an opening in the cast material;

Figure 3 shows a section I-I of Figure 1; and

Figure 4 shows a section II-II of Figure 2.

In the drawings the reference numeral 1 identifies a casing which is located in a borehole 2 of a formation 4.

The casing 1 is encircled by several sleeves 6 made of an expandable material.

The sleeves 6 are fitted to the casing 1 before the casing is run into the borehole 2, and the sleeves 6 thereby help the casing 1 not to be laid down completely on the bottom of the borehole 2.

Most advantageously, the sleeve 6 is provided with an externally penetratable, preferably durable cloth material 8. This material may also contain reinforcement in the form of metal bodies or synthetic fibre. The penetratable cloth material 8 inhibits the expandability of the sleeve 6 only to an insignificant degree.

After the casing 1 has been placed in the borehole 2, cast material 10, here concrete, is filled into a void 12 in the form of an annulus between the casing 1 and the borehole 2, see Figure 1.

As appears from Figures 1 and 3, the annulus 12 is not completely filled with cast material 10, as some drilling fluid 14 is present in the lower portion of the annulus 12.

This drilling fluid 14 which has not been displaced by the cast material 10, has the effect that a flow-permitting cannel 16 is formed along the borehole 2.

After some time the expandable material of the sleeve 6 has expanded, through the influence of the drilling fluid 14, for example, and displaced the drilling fluid 14 present between the sleeve 6 and the borehole 2, see Figures 2 and 4. The expandable material of the sleeve 6 now abuts the wall of the borehole 2, thereby sealing the longitudinal channel 16 to fluid flow.